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Article

Integrating Theory and Practice to Increase Scientific Workforce Diversity: A Framework for Career Development in Graduate Research Training

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Few, if any, educational interventions intended to increase underrepresented minority (URM) graduate students in biological and behavioral sciences are informed by theory and research on career persistence. Training and Education to Advance Minority Scholars in Science (TEAM-Science) is a program funded by the National Institute of General Medical Sciences at the University of Wisconsin–Madison with the twin goals of increasing the number of URM students entering and completing a PhD in BBS and increasing the number of these students who pursue academic careers. A framework for career development in graduate research training is proposed using social cognitive career theory. Based on this framework, TEAM-Science has five core components: 1) mentor training for the research advisor, 2) eight consensus-derived fundamental competencies required for a successful academic career, 3) career coaching by a senior faculty member, 4) an individualized career development plan that aligns students' activities with the eight fundamental competencies, and 5) a strengths, weaknesses, opportunities, and threats personal career analysis. This paper describes the theoretical framework used to guide development of these components, the research and evaluation plan, and early experience implementing the program. We discuss the potential of this framework to increase desired career outcomes for URM graduate trainees in mentored research programs and, thereby, strengthen the effectiveness of such interventions on participants' career behaviors.

INTRODUCTION

Numerous publications exist on interventions to recruit and retain undergraduate students from ethnic or racial minority groups who are underrepresented in biomedical and behavioral science (BBS; cf. McGee and Keller, 2007; Villarejo *et al.*, 2008), but comparatively fewer publications exist on the recruitment and retention needs of underrepresented minority (URM) graduate students. Increasing scientific workforce diversity is essential to the nation's economic vitality (Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development, 2000), and successful completion of the doctoral degree is imperative in preparing URM students for competitive research careers and becoming tomorrow's academic leaders in BBS. Academic leaders in BBS are also best positioned to reduce health disparities, because they forge the nation's research agenda, advise public policy makers, and train future physicians and scientists (Betancourt and Maina, 2004; Smedley *et al.*, 2004; U.S. Department of Health and Human Services, 2005). Recognizing the importance of diversifying the scientific workforce, the National Institute of General Medical Sciences (NIGMS, 2011) has invested in initiatives to increase persistence in research careers for URM graduate students, including the Initiative for Maximizing Student Development (IMSD). The Training and Education to Advance Minority Scholars in Science (TEAM-Science) program is one such IMSD-funded initiative targeting URM BBS doctoral students at the University of Wisconsin–Madison (UW). This paper describes the theoretical framework used to guide development of the TEAM-Science program

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components, the research and evaluation plan, and the potential of this framework to increase desired career outcomes for URM graduate trainees in mentored research programs, and thereby strengthen the effectiveness of such interventions on participants' career behaviors.

WHY SO FEW? A CAREER DEVELOPMENT QUESTION

Over one-half of URM undergraduates in BBS intend to earn a postbaccalaureate degree (Hurtado *et al.*, 2006), but URM individuals comprise only 10% of doctoral degrees awarded in all science, technology, engineering, and mathematics (STEM; Bell, 2009), a category that includes BBS. This underrepresentation is not for lack of ability or interest in science (Seymour and Hewitt, 1997). Underrepresentation appears to be a problem of translating URMs' abilities and interests into persistence. Strategies for sustaining and translating students' interests and abilities into actual career pursuits are the domain of vocational psychology theory. A persistent challenge to advancing effective strategies to broaden URM participation in BBS is the dearth of theoretically based research training programs in general, and particularly the dearth of such programs based in vocational and career theory.

Lack of theoretically informed interventions is problematic. Without knowledge of what specific factors influence career choice and how those factors relate to one another, interventions rely on anecdotal evidence and unsubstantiated strategies and therefore lack the precision to maximize participants' career outcomes. For instance, research indicates that common research training program components like mentoring (Pfund *et al.*, 2006) and scientific writing development (Shah *et al.*, 2009) are important factors for building research careers. Yet it is unverified how such program components relate to desired participant outcomes, leaving research training programs without empirically supported direction for ways to best integrate and deliver these components. Interventions that are atheoretical and lack empirical support therefore threaten the effectiveness of such efforts to increase the numbers and diversity of people pursuing BBS careers.

Thus, a theoretically informed, conceptual framework is needed to direct effective practices for promoting career development, as well as research skill development, of URM graduate students in BBS. Such a framework would enable training programs to better articulate intended outcomes, recognize assumptions made, identify strategies with specific aims against which to measure program outcomes, and understand the efficacy of program components in order to determine causal relationships between program elements and intended behavioral outcomes or skill acquisition (Poodry, 2006). As persistence in a given career path is a vocational process, innovative programmatic interventions informed by career development theory are needed to increase the success of URM graduate students in BBS. Indeed, NIGMS' Strategic Plan for Biomedical and Behavioral Research Training (2011), *Investing in the Future,* acknowledged that all trainees should become proficient in competencies that facilitate successful pursuit of a scientific career *and* should receive quality career guidance. One way to enhance the effectiveness of research training programs is to use theoretically derived career development processes and resources to help graduate trainees maximize their mentored research experiences and increase their BBS career pursuits.

This paper proposes a theoretical framework, drawn largely from social cognitive theory, to articulate program elements likely to be effective in advancing career development outcomes in graduate research training interventions. Over 30 yr of research applying social cognitive theory to academic and career choice (Betz and Hackett, 1981; Lent *et al.*, 1994) has resulted in recommended strategies and resources from which training programs can benefit to enhance intervention effectiveness in promoting BBS research career pursuits. We describe the components of the framework for career development in graduate research training (F-CGRT), the theoretical or empirical justification for inclusion of each component, and the experience of the first cohort of graduate students to enter the TEAM-Science program. This is not a full test of the proposed framework, but an exploration of its potential utility to increase the effectiveness of research training on URM participants' career development outcomes in BBS. Participant data are used to reflect on the extent to which TEAM-Science graduate students' experiences are consistent with the assumptions of the F-CGRT.

The articulation of this theoretically and empirically based framework may allow for posing research questions about program effectiveness, such as what is the relative relationship of the program components to participant outcomes (e.g., research productivity, commitment to research career, actual career entry)? Such inquiry goes beyond traditional program evaluations (e.g., degree completion rates). If implemented, it is hypothesized that the F-CGRT may be useful in guiding development of mentored research programs for URMs and could conceivably increase the effectiveness of such interventions on participants' career outcome behaviors.

NEEDS ASSESSMENT, PROGRAM DESIGN, AND IMPLEMENTATION

Why TEAM-Science?

The TEAM-Science program goals are twofold, consistent with the IMSD initiative: to increase the number of URM students entering and completing a PhD in BBS, and to increase the number of URM graduate students who pursue academic careers in BBS. IMSD requires that program activities be designed based on institutional self-assessment relative to the research environment, challenges and impediments to advancement to the next step in training, and completion of the PhD degree. The TEAM-Science program emerged from a needs assessment that included review of research relevant to the graduate training of URM students in STEM and BBS and interviews with faculty and administrators involved in graduate education and diversity efforts at the UW. In 2003, some of the leaders of TEAM-Science then convened a listening session in which all URM graduate students in STEM/BBS disciplines were invited to attend an evening session with the dean and associate deans of the UW Graduate School. Thirty-seven URM students from over 10 graduate programs attended. Students were provided the opportunity to describe barriers and facilitators to their graduate school success. Many students expressed feelings of isolation ("not on anybody's radar"), needing to "learn on the fly," and a lack of professional mentoring ("more important than race

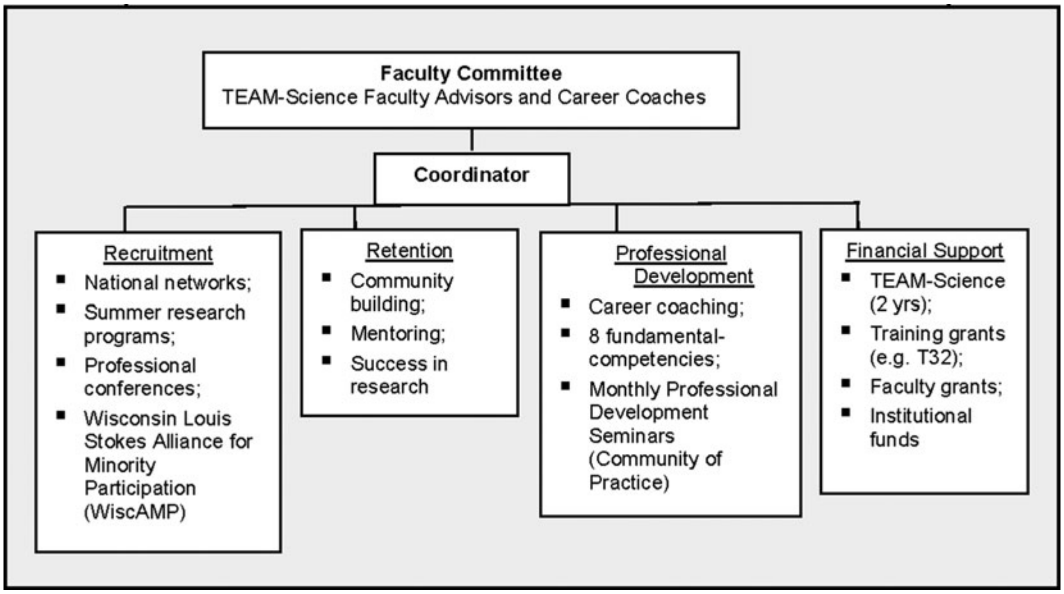

Figure 1. Basic GRS program structure adapted for TEAM-Science.

is someone who cares"). Several of the themes that emerged supported the need for a program such as TEAM-Science. The various components of TEAM-Science were subsequently designed to address these identified needs.

One graduate training program for URM students at UW is the Graduate Engineering Research Scholars (GERS) program aimed at increasing both enrollment and graduation rates for URM graduate students within the UW College of Engineering. GERS has been the most successful URM graduate training program on campus since its inception in 1999 (e.g., three-fold increase in URM engineering graduate student enrollment). Consequently, in the past 5 yr, the UW Graduate School has promoted the GERS model, known as the Graduate Research Scholars (GRS) communities, to other UW schools and colleges—the College of Letters and Science, School of Education, and, jointly, the College of Agricultural and Life Sciences and the School of Medicine and Public Health now have established similar programs. Essential elements of the GERS model are: 1) guaranteed financial support to complete a PhD at the time of recruitment (4–5 yr, depending on field and contingent on continued academic success), 2) oversight through a faculty committee, 3) student community-building activities, and 4) a designated coordinator. TEAM-Science includes and builds on these components, as illustrated in Figure 1 and discussed further in the following sections.

Program Design

TEAM-Science provides financial support (e.g., tuition and fee remission), conference travel funding, and employment for two consecutive years of each student's graduate program, and the faculty member submitting the application must indicate the source of funding for the other years (e.g., T32 National Research Service Award or institutional funds). A program coordinator maintains regular contact with all TEAM-Science scholars and organizes and manages the TEAM-Science program components, including the monthly professional development seminars, which are offered year-round. Selected speakers facilitate discussions based on topics, most of which are chosen by the scholars. Topics include common professional development matters, such as getting the most from mentoring relationships and planning for a postdoctoral position, as well as deliberate discussions of diversity issues that can unintentionally affect the career advancement of URM students, such as implicit bias and stereotype threat (Steele, 1997; Greenwald *et al.*, 1998), along with strategies to mitigate such negative impacts. These seminars constitute a formal "community of practice," as articulated by the cognitive anthropologists Lave and Wenger (1991). A community of practice is a group of people who share an interest or profession and has the following three components: mutual engagement, joint enterprise, and shared repertoire (i.e., a set of communal resources; Wenger, 1998). Members of the TEAM-Science community benefit from collective learning and from sharing experiences and accomplishments as URM doctoral students in BBS. This learning and sharing includes activities like problem solving and resource identification by capturing the group members' tacit knowledge, or their "know-how" that, in turn, can lead to higher productivity (Wenger, 2004).

Participating faculty members in TEAM-Science lead recruitment of individual students through several means, including national networks of professional organizations, BBS-related conferences, summer research programs, and the Wisconsin Alliance for Minority Participation (a National Science Foundation–funded program). Students are selected into TEAM-Science through faculty nominations once they are regularly admitted into a BBS doctoral degree program. Applications are reviewed by a committee. Students may enter TEAM-Science at any part of their doctoral studies, with some beginning the program in their first year of doctoral

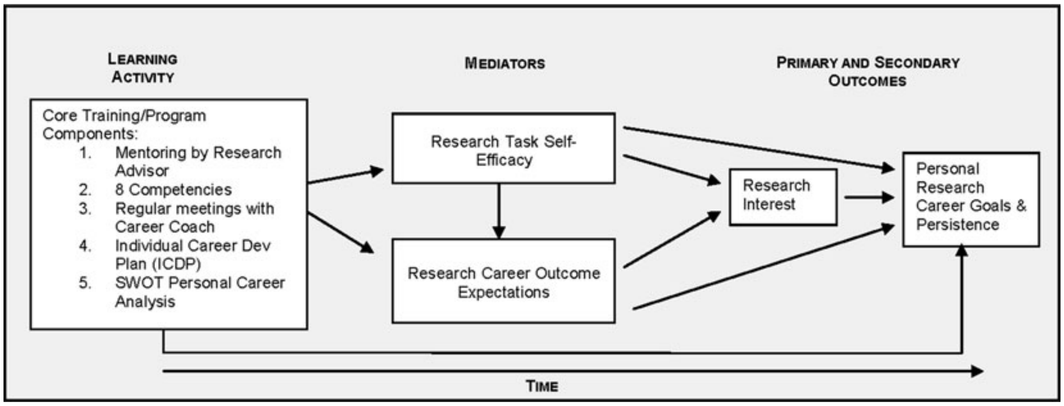

Figure 2. TEAM-Science conceptual model based on social cognitive career theory.

studies and others beginning later in their doctoral studies. TEAM-Science is funded to support a maximum of 10 students per year. Students can be in any BBS graduate program, but the student's research must in some way link to improving the health of women or the biology of sex and gender differences, because TEAM-Science is administered through the UW Center for Women's Health Research (Carnes *et al.*, 2001, 2006). Faculty participating in TEAM-Science receive no incentives.

Although TEAM-Science incorporates design elements common to other BBS URM graduate research support programs at UW, there are several distinguishing program features that set TEAM-Science apart. In addition to common group learning opportunities that augment the individual mentored-research training, TEAM-Science emphasizes academic developmental activities centered on career choice and commitment. This is achieved in two ways, the combination of which does not exist in other graduate research training programs at UW or elsewhere, to our knowledge: 1) training of faculty mentors and creation of career coaches, and 2) development of three structured career intervention strategies. We proposed the F-CGRT, which includes theoretically based content and curricula for the mentor and career coach training to assist faculty in better achieving the intended goals. The next several paragraphs describe the F-CGRT underlying TEAM-Science, including the theoretical foundation, critical learning activities, and career development interventions.

F-CGRT

Theoretical Foundation for the F-CGRT

The TEAM-Science program incorporates concepts from social cognitive theory applied to academic and career development, commonly referred to as social cognitive career theory (SCCT; Lent *et al.*, 1994, 2000). Poodry (2006) acknowledged the growing literature on academic and career experiences of URM and women from relevant psychology and sociology fields. He suggested that this literature be reviewed in a way as to be made more accessible to scientists in other fields (e.g., biology) who are interested in broadening URM participation (see Byars-Winston [2010] for a summary of career theory relevant to STEM). The theoretical underpinnings of F-CGRT are briefly summarized herein. Readers are referred to the original and additional sources cited for fuller discussion of the theory.

SCCT explicates the mechanisms whereby individuals develop career interests and goals. According to SCCT, career interests and pursuits develop by means of three intricately linked variables: 1) self-efficacy (confidence in one's ability to be successful at a given task), 2) outcome expectations (anticipated consequences of one's actions), and 3) personal goals (Lent *et al.*, 1994). Figure 2 illustrates how self-efficacy and outcome expectations are posited to inform interests and persistence in BBS research careers. Statistically significant relationships from self-efficacy and outcome expectations to interests and goals have been found for URM students in science and engineering (Byars-Winston *et al.*, 2010; Sheu et al., 2010) and for biomedical and clinical researchers with ethnically diverse scholars (Bakken *et al.*, 2006, 2010). SCCT is concerned with two primary levels of performance: 1) level of attainment and 2) persistence (Lent *et al.*, 1994). The TEAM-Science program is evaluated, in part, on these two performance factors.

One of the IMSD-stated outcomes of funded programs is that they will facilitate determination of which strategies are effective and therefore should be institutionalized. We posit that application of the F-CGRT will enable TEAM-Science and other graduate training programs to empirically examine theoretically coherent relationships between program components and intended participant outcomes and, in turn, identify those strategies that are effective and appropriate for institutionalization.

Program Components

As depicted in Figure 2, several key learning activities are proposed that translate the theoretical assertions in F-CGRT into practice. Specifically, five core program components are used in the TEAM-Science training program to facilitate research-related self-efficacy beliefs, outcome expectations, and personal goals. The first core component is research advising. The program drew training faculty from different graduate programs in BBS, linked through the broad theme of women's health research, to serve as doctoral research advisors to TEAM-Science graduate students. Mentor support is a strong predictor of career persistence for URM undergraduate students (Gloria *et al.*, 1999). Notably, in many BBS disciplines, URM faculty are so few that URM students can earn a baccalaureate or doctoral degree "without being taught by or having access to a URM professor in that discipline" (Nelson and Brammer, 2010, p. 1). Thus, great care was taken in identifying and selecting a qualified and ethnically diverse group of TEAM-Science faculty in research mentoring roles. Representing 12 graduate training programs, TEAM-Science has 27 active or potential research advisors: 14 male and 13 female (48%), four (15%) of whom (one male and three female) are URM individuals (three African American and one Hispanic). In contrast, 4.7% of faculty in the 86 BBS departments relevant to TEAM-Science are URM individuals.

Beyond providing the traditional mentored research experiences common to graduate training, TEAM-Science research advisors facilitate graduate students' development of academic career competencies. These competencies constitute the second core program component. In developing TEAM-Science, we posed electronically a query to a wide range of faculty, asking them to identify fundamental competencies that all graduate students—regardless of discipline—needed to work toward if they were to be successful and prepared to advance toward an academic career. Faculty who responded to this query, not necessarily affiliated with TEAM-Science, included over 30 faculty in BBS and other broad STEM areas (e.g., mathematics) from three doctoral degree–granting institutions in Wisconsin, including UW. Our premise was that if we could all agree on these competencies, on how the various graduate program activities aligned with them, and on how we could determine whether TEAM-Science scholars were progressing toward successful competency in each area, then—regardless of the department or graduate program—we could collate a menu of opportunities and activities to assure that our students attain the essential knowledge, skills, and experiences required to advance toward the professoriate. We also expected the clarity of this competency-based approach to promote self-efficacy and positive outcome expectations for achieving an academic career. Competency-based training has been found to increase research self-efficacy for men and women in clinical research (Bakken *et al.*, 2010). Starting with the six competencies described by Bakken (2002) for a learner-centered training program for clinical research, we had an iterative electronic dialogue with our solicited faculty from which emerged eight final fundamental academic career competencies. These competencies are:

1. *Research excellence:* Acquire research expertise in a particular BBS area.
2. *Study design, data collection, and analytical techniques:* Investigate a cutting-edge research problem employing discipline-specific techniques.
3. *Leadership/management:* Manage research teams and provide leadership in advancing a BBS discipline.
4. *Oral communication of research findings:* Communicate knowledge through verbal presentations in different types of venues to a variety of audiences.
5. *Scientific writing:* Write well-organized and logical abstracts, journal publications, research proposals, and grant applications.
6. *Responsible conduct of research:* Conduct research according to professional ethics and regulatory guidelines.
7. *Teaching excellence:* Teach others through classroom teaching and individual mentoring incorporating evidence-based strategies for teaching and learning.
8. *Collaboration:* Communicate and cooperate with others within and across disciplinary boundaries and national borders.

To enhance their mentoring effectiveness, research advisors participate in a 2-h mentor training workshop facilitated by a nationally renowned leader in research mentor training (Pfund *et al.*, 2006). The workshop reviews critical ingredients of effective research mentoring, as well as strategies for facilitating achievement of the eight fundamental competencies.

The final three core program components of TEAM-Science include structured career intervention strategies that are innovative and unique in their combined offering within the F-CGRT: career coaching, an individual career development plan (ICDP), and a strengths, weaknesses, opportunities, and threats (SWOT) personal career analysis. The F-CGRT is designed to close the gap between where graduate students currently are and where they want to be in their career, as well as to support their research success. Therefore, F-CGRT includes and offers purposeful career interventions to program participants. Career interventions is a broad category term referring to any activity designed to facilitate career development, such as career exploration, career clarification, and job search strategies. The three career intervention strategies used in TEAM-Science are described next, with a fuller discussion of career coaching to explicate its conceptual underpinnings as a specific career development technique; the ICDP and SWOT personal career analysis are specific career development tools.

Career Coaching. Career coaching involves aspects of career counseling, organizational consulting, and employee development (Chung and Gfroerer, 2003). Often referred to as "consulting for the 90s" (Bell, 1996), the concept of career coaching evolved largely out of the business industry, where managers facilitated employees' professional advancement through the organization via strategic career planning (e.g., managerial career coaching). Career coaches serve as personal "consultants who mentor their clients through career challenges and motivate them to achieve realistic goals" (Strempel, 1999, p. 5). Recognizing the value of career coaching, some professional societies are offering sessions with certified career coaches at their annual meetings (American Public Health Association, 2010).

Career coaching has three distinct components: coaching (suggests specific strategies for achieving career aspirations and/or for achieving recognition within an organization), sponsorship (encourages or facilitates desired mobility), and exposure (brings attention to protégé's accomplishments to enhance her/his visibility; see Fulmer *et al.*, 2006). Career coaching is distinct from career counseling, in that the latter is characterized by interactions that are psychological in nature (Swanson, 1995) and usually conducted by an individual with formal training as a professional counselor (Chung and Gfroerer, 2003). Career coaching is also distinct from mentoring in several ways. Mentoring is a "dynamic reciprocal relationship" between an advanced career incumbent and a less-experienced professional (protégé) aimed at promoting the development and fulfillment of both (Healy, 1997; Palepu *et al.*, 1998; Sambunjak *et al.*, 2006). It is designed to support both the career *and* psychosocial development of the protégé (Ehrich *et al.*, 2004). Both career coaching and mentoring involve disseminating useful firsthand knowledge. However, mentoring may focus more on increasing a protégé's specific task ability (e.g., learning how to perform a particular laboratory or analytical technique), while career coaching focuses on providing contextual information to a protégé (e.g., tools and tactical advice and/or strategies for managing organizational politics). In this vein, career coaching can be viewed as a specific form of career development mentoring, providing guidance toward an individual's career aspirations. In TEAM-Science, each student is paired with a career coach who is a senior faculty member in BBS, but not her/his research advisor, and who serves as an external facilitator to help address career issues. The career coach does not need to be—and usually is not—familiar with the specific type of research in which the TEAM-Science scholar is engaged. Of the four career coaches, two are white, female, physician scientists who are tenured full professors; one is an African-American, male, tenured full professor in engineering; and one is a white, male, tenured full professor in reproductive endocrinology. The career coaches receive some compensation for their participation in the TEAM-Science program.

Career coaches participate in an intensive, half-day training workshop (see Supplemental Material; http://videos.med.wisc.edu/presenters/846) led by a PhD counseling psychologist who is an African-American woman with expertise in career development for science, engineering, and medicine (A. B.-W.). The workshop covers the topics of mentoring, the three distinct ingredients of career coaching, career development theory, and general communication skills. For the first academic semester that students are in TEAM-Science, they meet monthly with their career coach; at least one of these meetings includes the research advisor. Thereafter, the scholar and career coach meet at least once a semester. The career coaching sessions are guided and informed by the next two career development facilitation strategies.

ICDP. The ICDP provides a tabular outline of the eight fundamental competencies that TEAM-Science scholars fill out in order to formally identify and assess in writing 1) goals they wish to pursue, 2) specific products to be completed with a timeline, 3) necessary supports to meet those goals, and 4) short-term needs for improving current performance. We have added personal goals as a ninth area to explicitly validate the importance of work–life balance to long-term academic career success in BBS. The ICDP includes a four-step outline for both students and career coaches to develop, implement, and continually revise the ICDP throughout the program. ICDPs are an important component of the broader mentoring structure within TEAM-Science, as they facilitate communication among the scholar, career coach, and research advisor, so that all share the same set of expectations and can identify together the supports needed as the scholar works toward achieving specific objectives.

SWOT Personal Career Analysis. SWOT analysis is commonly used in business industry and was adapted for use in career development (Jensen, 1998; www.quintcareers.com). The acronym SWOT stands for strengths, weaknesses, opportunities, and threats (both internal and external factors). This tool aids in students' strategic assessment of likely facilitators of and inhibitors to achieving their research career goals. Students complete the SWOT personal career analysis with their career coach upon entering the TEAM-Science program. Both the ICDP and the SWOT personal career analysis are tools that allow students to have ongoing, systematic discussions and examinations of their research self-efficacy, outcome beliefs, and career goals.

As a result of completing these three career development interventions, each student has a portfolio of materials documenting their achievement of academic and research-related competencies. In sum, the F-CGRT, as applied to the TEAM-Science program, is 1) unique in providing formal mentor training for faculty research advisors; 2) innovative in offering career coaching to graduate students; and 3) theoretically grounded in career development scholarship and career facilitation strategies to increase the academic and professional success of URM graduate students in BBS.

DESIGN-BASED RESEARCH AND EVALUATION PROCEDURE

TEAM-Science provides an opportunity to explore whether theoretical assumptions of the F-CGRT could be effectively translated into practice. Program evaluation for the TEAM-Science program using the F-CGRT is based on a logic model approach (Kellogg Foundation, 2004; see Figure 3). The logic model describes a program and its theory of change; it is a graphical representation of the desired relationships between program investments and program results (University of Wisconsin Extension, 2008). The outputs or learning activities, operationalized by the five core program components listed in Figure 2, are evaluated, along with students' ratings of the perceived usefulness of these learning activities and other TEAM-Science offerings (e.g., monthly professional development seminars). These activities are expected to sustain and inform students' research self-efficacy beliefs, positive outcome expectations, and research interests. In turn, these beliefs support short- and medium-term behavioral outcomes related to developing a research career, and ultimately increasing the diversity within BBS research careers and academic leadership.

Principles of design-based education research methodology (Design-Based Research Collective, 2003) informed this study (cf. DeWitt and Osborne, 2007). The goal of this methodology is pragmatic, focusing on determining whether an intervention, resource, or activity functions as intended by the designers. Interventions are conceptualized and designed according to theory, implemented in a given setting, and the ecological validity of dominant theory is subsequently tested. Importantly, scholars note that design-based research is not merely designing and testing interventions; as interventions embody theoretical claims about teaching and learning, research on specific interventions suggests a commitment to understanding the relationships among theory and practice as well (Design-Based Research Collective, 2003). Therefore, this methodology may also lead to further theorizing on the F-CGRT, as well as informing subsequent research trials in

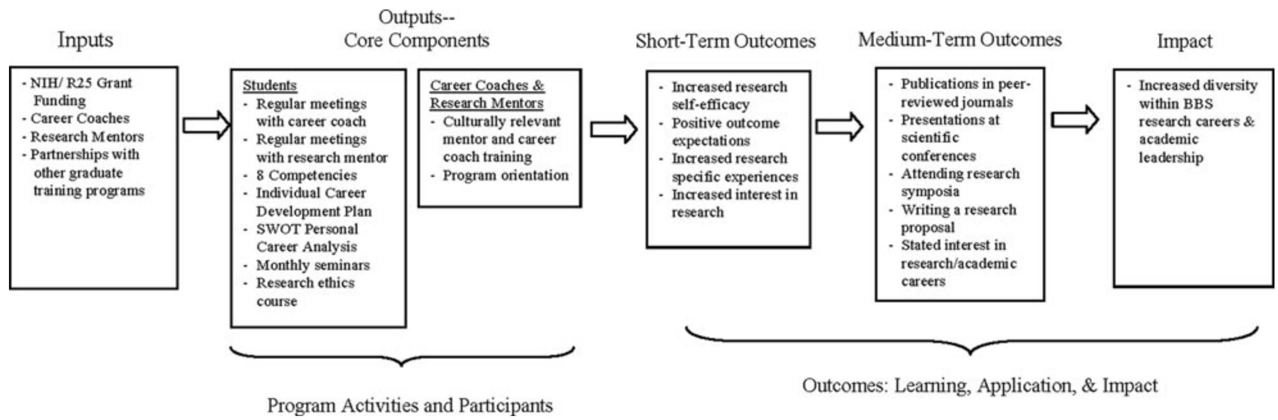

Figure 3. Logic model for evaluation of TEAM-Science program.

multiple contexts that can substantiate the broader impact potential of F-CGRT.

Consistent with the F-CGRT logic model, the level of students' performance attainment was quantified by external measures, such as peer-reviewed journal publications and conference presentations, progress toward the eight fundamental competencies, completion of a research ethics course as required by the National Institutes of Health (NIH), and completion of the SWOT personal career analysis and ICDP. This information is collected by the TEAM-Science program coordinator. Persistence is gauged by students' stated intent to pursue BBS careers and specific career plans, such as enrollment in postdoctoral programs. Students' research self-efficacy beliefs, positive outcome expectations, research interests, and number of research-related experiences (e.g., writing a research proposal, preparing a research poster) are assessed each semester with four measures.

The Research Self-Efficacy Scale (Bieschke *et al.*, 1996) measures students' belief in their ability to perform functions related to conducting research (e.g., "to generate researchable questions or to develop a logical rationale for your particular research idea") on a scale ranging from 1 (no confidence) to 10 (complete confidence). The Research Outcome Expectations Questionnaire (Bieschke, 2000) measures students' expectations of what a career in research will provide for them (e.g., "Involvement in research will enhance my job/career opportunities") on a scale ranging from 1 (strongly disagree) to 5 (strongly agree). The Interest in Research Questionnaire (Bieschke, Bishop, and Herbert, 1995) instructs students to rate their degree of interest in research activities (e.g., analyzing data) on a scale ranging from 1 (very disinterested) to 5 (very interested). Finally, the Research Experiences Inventory (Hollingsworth and Fassinger, 2002) assesses the quality of students' working relationships with their research advisors (e.g., "to what extent does your research mentor expose you to different research methods?") on a scale ranging from 1 (very little) to 5 (a great deal). All data are collected once a semester via a self-report web survey that takes approximately 15 min to complete—surveys are de-identified (i.e., students are assigned a TEAM-Science program identification number instead of their name). The research reported was reviewed by UW's Education Research Institutional Review Board and deemed exempt (IRB Protocol # SE-2008-0660).

PROGRAM RATINGS AND OUTCOMES

In this section, we describe the early experience with program ratings and short- and medium-term outcomes. The outcomes of TEAM-Science scholars are reported following the logic model for the F-CGRT. Descriptive statistics summarize the student, faculty mentor, and career coach data. The data were evaluated based on whether or not the program components (e.g., interventions and resources) fit participants' perceived needs and whether or not they promoted intended outcomes according to F-CGRT.

Participant Profiles

To date, 17 students in 12 doctoral programs have been supported through the TEAM-Science program. Of these students, 47% are black/African American, 35% are Hispanic, 18% are Native American or indigenous peoples of Hawaii, Alaska, or the U.S. territories. In comparison, at UW in the fall of 2010, of the 8510 graduate students enrolled in the 86 BBS departments relevant to TEAM-Science, 2.5% are African American, 2.9% are Latino, and 0.6% are Native American or Native Hawaiian. Prior to matriculation in doctoral programs at the UW, TEAM-Science students earned degrees (baccalaureate or master's) from 14 different institutions in nine states (and one in Washington, DC). Six TEAM-Science students came from research universities with very high research activity according to the Carnegie Classification System, five came from universities with high research activity, five came from either large or medium master's degree–granting colleges and universities, and one came from a baccalaureate-only–granting college of arts and sciences. Most program participants enrolled thus far continue to be funded through TEAM-Science, and others have graduated or transitioned to support from other sources (e.g., T32 programs). At this early stage, the impact of a relatively small program like TEAM-Science on an institution with such a large graduate program is difficult to ascertain. All TEAM-Science students are meeting the requirements of their individual graduate programs

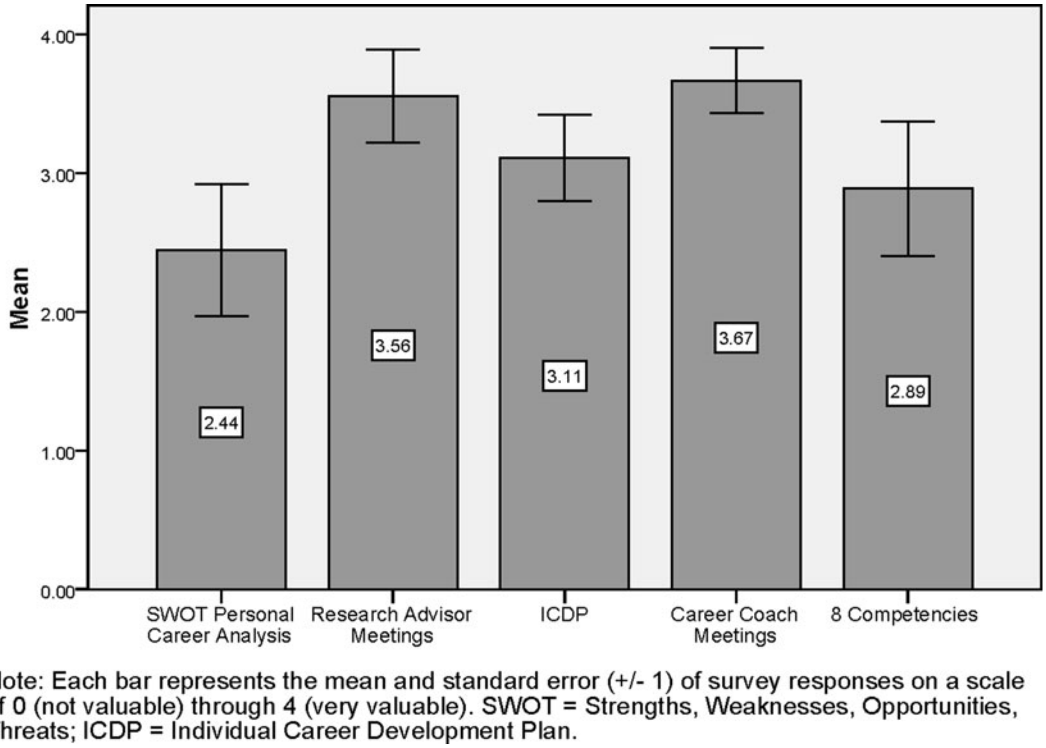

Figure 4. Students' ratings of core program components, $N = 9$.

in terms of GPA and research productivity. We will track TEAM-Science students following completion of their doctoral studies to determine their academic progress in terms of postdoctoral fellowships, faculty appointments, publications, and awards.

Program Ratings

Overall ratings of the TEAM-Science learning activities consisting of the five core components were favorable (Figure 4). For the most recent program evaluations conducted (Spring 2010), nine of the 10 students enrolled provided responses. Students rated the perceived value of each program component to their academic and career development on a 5-point scale ranging from 0 to 4, with 4 indicating the most value. The meetings with the career coach and research advisors were the most highly rated (3.67 and 3.56, respectively), followed by the ICDP (3.11), the eight academic career competencies (2.89), and the SWOT personal career analysis (2.44). Following are a sampling of quotes from the graduate students about the value of the five core components.

Career Coaching

"…in their current structure they facilitate powerful results. Specifically, they make me think every month about whether or not I'm on a career path that I find satisfying. They also help me to keep track of what things I'm actually doing to stay on track and to continue advancing in my own education and career."

Research Advisors

"I have had really terrible advising relationships prior to working with mentors in the TEAM-Science training program, so my ratings are really reflective of my sense that I have a very welcoming, supportive, and instructive advisor. I feel very fortunate."

ICDP

"[the] ICDP helped [me] solidify and understand my role in topics I had not considered. It also helped me incorporate my personal goals and not just focus on research goals."

Eight Academic Career Competencies

"I am someone who is more of a big picture person, and I don't stop to really look at the details that often. This can lead to a feeling of being overwhelmed. So, this tool is very helpful for me because it makes me sit down and think through what I am doing, what I have done, and what I will do. This helps me to feel like I'm on track in my 'big picture'."

SWOT Personal Career Analysis

"This tool was the most helpful for me in bridging the gap between my personal, lived experience, and my experience as a student/research trainee. There are so many social and environmental factors that influence how I feel and think about my work and research. These same factors also influence how I perform my work. It is helpful, therefore, to have a place to think about them."

Given the centrality of the mentored research experience in advancing culturally diverse graduate students in BBS toward research careers (Chew *et al.*, 2003), TEAM-Science gathers additional data on students' working relationships with their research advisors using the Research Experiences Inventory. The mean scale response to this inventory was 4.29 (on a

5-point scale, with 5 being the best score). Out of the 28 items on this scale, the five most highly rated experiences (above 4.4) with the research advisor, in descending order, were: 1) expressing enthusiasm for research, 2) constructively criticizing students' research work, 3) exposing students to different research methods, 4) communicating respect regarding cultural differences in the mentoring relationship, and 5) observing connections between research and practice.

Short-Term Outcomes

The results reported here are for all 10 TEAM-Science students who were enrolled in the program during Spring 2010. Seven new students were enrolled in the Summer and Fall 2010 sessions, and thus no survey data were available for them.

Students' self-ratings in response to items on three measures related to SCCT were also generally favorable. TEAM-Science students rated their research self-efficacy beliefs relatively high, as reflected in the mean rating of 5.90 (on 7-point scale). Students' outcome expectations for pursuing research and a research career were generally positive (mean = 4.51, 5-point scale). Lastly, students reported high interests in research activities, as indicated in the mean scale rating of 4.22 (on 5-point scale).

Medium-Term Outcomes

Medium-term outcomes were gathered for the 10 students enrolled in TEAM-Science during Spring 2010 by reviewing their curriculum vitae. While under the support of the TEAM-Science program, three students have co-authored papers published in peer-reviewed journals. All students ($n = 10$) have attended a research conference, eight have presented posters at conferences, and nine have given oral presentations of their research. Finally, over half of the participants indicated a continued interest in pursuing a research career in either an academic or a nonacademic setting ($n = 6$).

When TEAM-Science faculty mentors were asked, "What advantage, if any, does participation in the TEAM-Science Program confer on your students who are in the program vs. non-TEAM-Science students in your own department or lab?," several noted that participants have "access to well-organized and available resources to help with their professional development" and the "opportunity to interact with other TEAM-Science students in presenting their research at program meetings." One faculty mentor stated,

> TEAM-Science gives them excellent guidance in career management and planning. My TEAM-Science students do a much better job of organizing their schedules, planning which experiments they need to do, and knowing how to get them done. They are also much better at charting out their careers years in advance—investigating which journals to publish in, knowing how to network at meetings, exploring different career options etc. . .

In sum, program characteristics that participants reported as particularly valuable in facilitating their academic and career development outcomes include structured mentoring relationships independent of the student's research advisor and facilitated reflection on one's career development and related plans. The data reported here suggest that the F-CGRT underlying TEAM-Science is useful in advancing URM participants' research skills and career development.

PRACTICE AND RESEARCH IMPLICATIONS OF THE F-CGRT

Much of graduate training is influenced by the apprenticeship model, where the master–novice relationship dominates (see Long *et al.*, 1996; Stewart and Lagowski, 2003). This model may be effective in producing a journeyman but not necessarily effective in preparing and producing future faculty and emerging leaders in academia. Indeed, Bogue *et al.* (2010) recently asserted that many trainees in science are "prepared for work, not the career," acknowledging that academic training equips graduates with the technical skills for job success but provides comparatively no preparation for developing one's career, balancing work–life matters, or managing professional challenges. Effective graduate education, therefore, necessitates a focus on graduate students' professional development "beyond the apprenticeship" that adopts the collegial model, wherein graduate students are engaged as active, reflective participants in their own graduate education and professional preparation (Long *et al.*, 1996). Simply put, we must broaden the focus of professionalization and rectify the imbalance between training for research and training for a career. In this vein, F-CGRT provides a theoretically informed structured training approach through which URM graduate students, in collaboration with their research advisors and career coaches, can transform their preprofessional academic activities into purposeful preparation for a research career in BBS.

Although our experience with the F-CGRT through the TEAM-Science program illustrates a translation of theory into practice, our work to date has a number of limitations in assessing the impact of the program and predicting its replication. The program is new, so the academic outcomes of the students remain unknown; the students are active participants in TEAM-Science for only two years of their full doctoral degree program; and the faculty who serve as research advisors and career coaches were carefully selected. Students' evaluations of the TEAM-Science program components were generally favorable, but we recognize that individual learning styles, unique mentoring needs, and the developmental status of the students all influence how they use the program components. For instance, discussing topics like "life beyond graduate school" (e.g., finding a postdoc position) and crafting a specific career plan using the ICDP may take on a different meaning for TEAM-Science students who have reached dissertator status than for students who are in their first or second year of doctoral study. By offering a variety of theory-based program components, like research mentoring, career coaching, and several career development tools—as articulated in the F-CGRT—we expect that the diversity of students' needs can be better met than in traditional programs. In spite of these limitations, our experience to date favors our predictions that graduate education programs aimed at increasing URM students' pursuit of academic BBS careers may be well-served to 1) incorporate formal career development interventions, such as the ones described in this paper, as well as 2) utilize career coaches to facilitate reflection on and integration of career-related exploration.

Practice implications from application of the F-CGRT include, foremost, the increased ability of programs to articulate their intended outcomes and assumptions regarding how program components or strategies are expected to impact those outcomes. For instance, in Figure 3 the logic model for the F-CGRT, as applied to TEAM-Science, clearly operationalizes what short-, medium-, and long-term outcomes are anticipated as a consequence of implementing the core program components. A second practice implication is the value of required training for faculty mentors serving as research advisors and for those serving as career coaches. Mentors seldom receive training on the mentoring process and therefore may be ill-equipped to assume mentoring roles and functions. White women and URM men and women in the sciences are especially at risk for inadequate mentoring relationships (Chew *et al.*, 2003). Thus, incorporating formal training for faculty who serve as research advisors, mentors, and career coaches may build their mentoring and coaching efficacy, as well as their cultural competence, in working with URM graduate students. A third practice implication is use of the consensus-derived eight fundamental competencies, which may provide a useful roadmap toward the professoriate for graduate students in BBS beyond the UW. Moreover, the extant program outcome data illustrate students' reported value of the structured career development activities, including the ICDP and the SWOT personal career analysis, with the most highly rated program component being meetings with career coaches. Thus, other research training support programs may do well to consider that the career coaches are not necessarily matched with a TEAM-Science student based on shared disciplinary background. Since the career coach is likely to be outside the students' discipline, the coach is particularly helpful in getting graduate students to think "outside of the box" of common career paths and positions for their field and to consider alternative settings in which to pursue a research career and leadership positions in BBS. Finally, another potential practice implication is the inclusion of open discussion of how group stereotypes can influence the evaluation of oneself, one's work, and even one's performance and evidence-based strategies to mitigate the negative impact of these cognitive processes. There is considerable research that such discussion itself is beneficial to members of URM groups (see www.reducingstereotypethreat.org), but it is not routinely integrated into the curricula of graduate programs.

Several research implications extend from the F-CGRT. The theoretically derived conceptual model that underlies the F-CGRT (see Figure 2) may enable programs to empirically identify the strategies that contribute to desired participant outcomes. Notably, the F-CGRT uses psychometrically valid measures that are theoretically consistent with the F-CGRT. Therefore, research can be conducted to determine which strategies are statistically related to the measured variables (e.g., self-efficacy beliefs) hypothesized to inform participants' persistence in the doctoral degree or their commitment to a research career, for instance. The conceptual model of the F-CGRT allows for further and fuller testing of the framework that can determine causal relationships between program elements and intended behavioral outcomes. In this vein, research using the F-CGRT has the potential to empirically identify effective strategies that are consequently appropriate for institutionalization. If further evaluation of the F-CGRT continues to be positive, its first dissemination will be to the other GRS communities supporting URM graduate students at UW. As a large, public, research university, UW shares many similarities with other such institutions, particularly those in the Midwest. We expect that the F-CGRT would be successful at other institutions besides the UW.

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REFERENCES

American Public Health Association (2010). Public Health CareerMart offers career guidance: services include job listings, résumé critiques, career coaching. The Nation's Health *40*, 3.

Bakken LL (2002). An evaluation plan to assess the process and outcomes of a learner-centered training program for clinical research. Med Teach *24*, 162–168.

Bakken LL, Byars-Winston A, Gundermann DM, Ward EC, Slattery A, King A, Scott D, Taylor RE (2010). Effects of an educational intervention on female biomedical scientists' research self-efficacy. Adv Health Sci Educ *15*, 167–183.

Bakken LL, Byars-Winston A, Wang M (2006). Viewing clinical research career development through the lens of social cognitive career theory. Adv Health Sci Educ *1*, 91–110.

Bell P (1996). Business coaches: the consultants of the '90s. Las Vegas Sun, March 18, 1D.

Bell N (2009). Graduate Enrollment and Degrees: 1999 to 2009, Washington, DC: Council of Graduate Schools.

Betancourt JR, Maina AW (2004). The institute of medicine report "unequal treatment": implications for health centers. Mount Sinai J Med *71*, 314–321.

Betz NE, Hackett G (1981). The relationship of career related self-efficacy expectations to perceived career options in college women and men. J Couns Psych *28*, 399–410.

Bieschke, KJ (2000). Factor structure of the research outcome expectations scale. J Career Assessment *8*, 303–313.

Bieschke KJ, Bishop RM, Herbert JT (1995). Research interest among rehabilitation doctoral students. Rehabilitation Education *9*, 51–66.

Bieschke KJ, Bishop RM, Garcia VL (1996). The utility of the research self-efficacy scale. J Career Assessment *4*, 59–75.

Bogue B, Chubin D, Comedy (2010). Prepared for work, not the career. Building science, engineering & technology leadership. Report of a PAESMEM/AAAS Workshop for Women in Industry, Academia and Government, 1–2 October 2009. www.lulu.com/product/paperback/prepared-for-work-not-the-career-building-science-engineering-technology-leadership/14694396.

Byars-Winston A (2010). Putting theory to work: developing careers in science and engineering. In: Understanding Interventions That Broaden Participation in Research Careers, ed. DE Chubin, AL DePass, and L Blockus, Washington, DC: American Association for the Advancement of Science, 25–32.

Byars-Winston A, Estrada Y, Howard C, Davis D, Zalapa J (2010). Influence of social cognitive and ethnic variables on academic goals of underrepresented students in science and engineering: a multiple groups analysis. J Couns Psychol *5*, 205–218.

Carnes M, Schuler L, Sarto GE, Lent SJ, Bakken LL (2006). Increasing sex and ethnic/racial diversity of researchers in aging: some promising strategies at the postdoctoral level. J Am Geriatr Soc *54*, 980–985.

Carnes M, Vandenbosche G, Agatisa PK, Kirshfield A, Dan A, Shaver JLF, Murasko D, McLaughlin M (2001). Using women's health research to develop women leaders in academic health sciences: the national centers of excellence in women's health. J Wom Health Gend Based Med *10*, 39–37.

Chew LD, Watanabe JM, Buchwald D, Lessler DS (2003). Junior faculty's perspectives on mentoring. Acad Med *78*, 652.

Chung YB, Gfroerer MCA (2003). Career coaching: practice, training, professional, and ethical issues. Career Dev Q *52*, 141–152.

Congressional Commission on the Advancement of Women and Minorities in Science, Engineering, and Technology Development. (2000). Land of Plenty: Diversity as America's Competitive Edge in Science, Engineering, and Technology. Report to Congress, September, 2000. www.nsf.gov/pubs/2000/cawmset0409/cawmset_0409.pdf (accessed 28 September 2011).

Design-Based Research Collective (2003). Design-based research: an emerging paradigm for educational inquiry. Educ Res *32*, 5–8.

DeWitt J, Osborne J (2007). Supporting teachers on science-focused school trips: towards an integrated framework of theory and practice. Inter J Sci Ed *29*, 685–710.

Ehrich LC, Hansford B, Tennent L (2004). Formal mentoring programs in education and other professions: a review of the literature. Educ Admin Q *40*, 518–540.

Fulmer IS, Barber AE, Derue DS, Morgeson FP 2006. The person and the situation: job seeker personality in the choice of and outcomes of career counseling. Academy of Management Best Conference Paper, CAR: D1.

Gloria A, Robinson Kurpius D, Hamilton K, Wilson M (1999). African American students' persistence at a predominantly white university: influences of social support, university comfort, and self-beliefs. J College Stud Dev *40*, 257–268.

Greenwald AG, McGhee DE, Schwartz JLK (1998). Measuring individual differences in implicit cognition: the implicit association test. J Pers Soc Psychol *74*, 1464–1480.

Healy CC (1997). An operational definition of mentoring. In Diversity in Higher Education: Vol. 1, Mentoring and Diversity in Higher Education ed. H Frierson, Jr., Greenwich, CT: JAI Press, 9–22.

Hollingsworth MA, Fassinger RE (2002). The role of faculty mentors in the research training of counseling psychology doctoral students. J Couns Psychol *49*, 324–330.

Hurtado S, Cerna OS, Chang JC, Saenz VB, Lopez LR, Mosqueda C, Oseguera L, Chang MJ, Korn WS (2006). Aspiring Scientists: Characteristics of College Freshmen Interested in the Biomedical and Behavioral Sciences, Higher Education Research Institute: University of California, Los Angeles.

Jensen D (1998). How to present your weaknesses during interviews. Science [Online] http://sciencecareers.sciencemag.org/career_magazine/previouszzz_issues/articles/1998_11_13/noDOI.6324139505850382630 (accessed 1 November 2010).

Kellogg Foundation (2004). W.K. Kellogg Foundation Logic Model Development Guide. www.wkkf.org/knowledge-center/resources/2006/02/WK-Kellogg-Foundation-Logic-Model-Development-Guide.aspx (accessed 27 November 2010).

Lave J, Wenger E (1991). Situated Learning: Legitimate Peripheral Participation, Cambridge, MA: Cambridge University Press.

Lent RW, Brown SD, Hackett G (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. J Vocat Behav *45*, 79–122.

Lent RW, Brown SD, Hackett G (2000). Contextual supports and barriers to career choice: a social cognitive analysis. J Couns Psychol *47*, 36–49.

Long MC, Holberg JH, Taylor MM (1996). Beyond apprenticeship: graduate students, professional development programs and the future(s) of English studies. WPA: Writ Prog Admin *20*, 66–78.

McGee R, Keller JL (2007). Identifying future scientists: predicting persistence into research training. CBE Life Sci Educ *6*, 316–331.

Nelson D, Brammer C (2010). A National Analysis of Minorities and Women in Science and Engineering Faculties at Research Universities, Norman, OK: Diversity in Science Association and University of Oklahoma. http://chem.ou.edu/~djn/diversity/Faculty_Tables_FY07/07Report.pdf (accessed 22 May 2011).

National Institute of General Medical Sciences (2011). Investing in the Future. Strategic Plan for Biomedical and Behavioral Research Training 2011. http://publications.nigms.nih.gov/trainingstrategicplan (accessed 28 September 2011).

Palepu A, Friedman RH, Barnett RC, Carr PL, Ash AS, Szalacha L (1998). Junior faculty members' mentoring relationships and their professional development in U.S. medical schools. Acad Med *73*, 318–323.

Pfund C, Pribbenow C, Branchaw J, Miller Lauffer S, Handelsman J (2006). The merits of training mentors. Science *311*, 473–474.

Poodry CA (2006). The scientific approach. Scientist *20*, s8.

Sambunjak D, Straus SE, Marusic A (2006). Mentoring in academic medicine: a systematic review. JAMA *296*, 1103–1115.

Seymour E, Hewitt NM (1997). Talking about Leaving: Why Undergraduates Leave the Sciences, Boulder, CO: Westview Press.

Shah J, Shah A, Pietrobon R (2009). Scientific writing of novice researchers: what difficulties and encouragements do they encounter?. Acad Med *84*, 511–516.

Sheu HB, Lent RW, Brown SD, Miller MJ, Hennessy KD, Duffy RD (2010). Testing the choice model of social cognitive career theory across Holland themes: a meta-analytic path analysis. J Vocat Beh *76*, 252–264.

Smedley BD, Butler AS, Bristow LR (2004). In the Nation's Compelling Interest: Ensuring Diversity in Its Workforce, Washington, DC: National Academies Press.

Steele CM (1997). A threat in the air: how stereotypes shape intellectual identity and performance. Am Psychol *52*, 613–629.

Stewart KK, Lagowski JJ (2003). Cognitive apprenticeship theory and graduate chemistry education. J Chem Educ *80*, 362.

Strempel D (1999). Career coach can answer age-old questions about life. Fairfield County Business J *38*, 5.

Swanson JL (1995). The process and outcome of career counseling. In Handbook of Vocational Psychology: Theory, Research, and Practice, 2nd ed., ed. W Walsh and S Osipow, Hillsdale, NJ: Erlbaum, 217–259.

University of Wisconsin Extension (2008). Planning a Program Evaluation Booklet. www.uwex.edu/ces/pdande/evaluation.

U.S. Department of Health and Human Services (2005). Seventeenth Report: Minorities in Medicine: An Ethnic and Cultural Challenge for Physician Training, Rockville, MD: U.S. Department of Health and Human Services.

Villarejo M, Barlow AEL, Kogan D, Veazey BD, Sweeney JK (2008). Encouraging minority undergraduates to choose science careers: career paths survey results. CBE Life Sci Educ *7*, 394–409.

Wenger E (1998). Communities of Practice: Learning, Meaning, and Identity, Cambridge, MA: Cambridge University Press.

Wenger E (2004). Knowledge management is a donut: shaping your knowledge strategy with communities of practice. Ivey Bus J *68*, 1.